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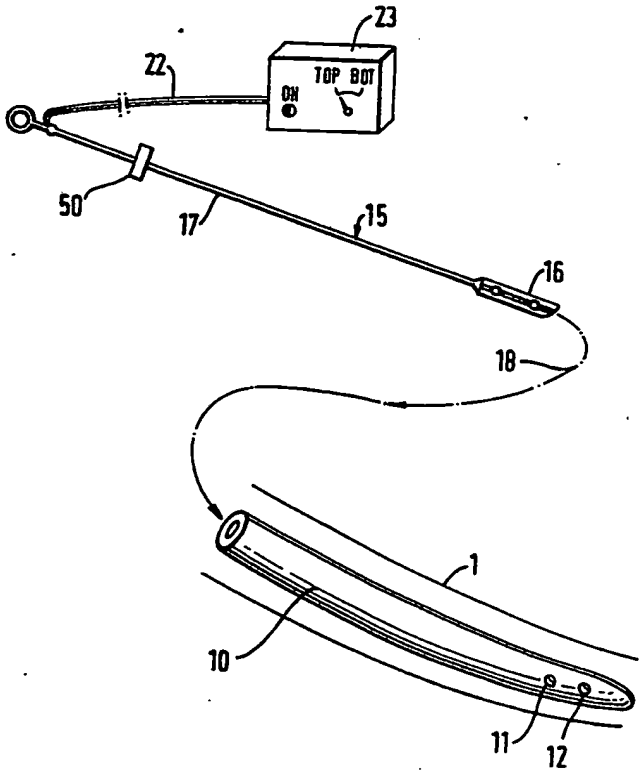
(54) Title: POSITION DETECTION

(57) Abstract

In order to determine accurately the location of a splint (10) within a bone (1), and so permit accurate drilling to locations matching the location of holes (11, 12) in the splint (10), a probe (15) is inserted into the splint (10). The probe (15) carries on a head (16) thereof transmission coils (20, 21) which are powered from a suitable transmitter (23) to generate magnetic fields. Those magnetic fields may then be detected by a detector having detection coils (30, 31). The position of the coils (30, 31) of the detector may be changed both linearly and rotationally until the detector (34) connected to the detection coils (30, 31) detects maximum signal strength. The detection coils (30, 31) are then aligned with one of the transmission coils (20, 21). Since the detection coils (30, 31) are on opposite sides of the splint (10), the line joining them corresponds to the axis of the appropriate hole (11, 12).



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POSITION DETECTION

The present invention relates to the detection of the location of an object, such as a splint or a specific part of a splint, within a human or animal body.

For serious bone fractures, it is sometimes necessary to insert a rigid support (hereinafter "splint") within the fractured bone, and to pin the part of the fractured bone to that splint to ensure that the bone can provide sufficient support whilst it heals. For example, for major fractures of a femur, it is necessary that the person must be able to stand whilst the bone heals, or else the person is immobilised for some time. Techniques already exist for insertion of rigid splints into bones, but a problem arises when the splint is to be pinned to the bone. Normally, such a splint has pre-formed holes therein, and after the splint has been inserted, it is necessary to drill through the bone at a location precisely matching the location of the holes, for the insertion of a suitable pin. Therefore, it is necessary precisely to determine the location of the splint and particularly the pre-formed holes of the splint within the bone.

Many techniques already exist for detection of objects within a living body, such as ultrasound investigations, but most are unsuitable for detection of the location of a splint within a bone because the

majority of techniques do not permit investigation within the bone. In existing systems, the only practical method of detecting the location of the splint and in particular the pre-formed holes is to use X-rays, but in order to obtain a sufficiently accurate measurement, long X-ray exposure times have to be used, which is dangerous to both the person being investigated, and the medical personnel carrying out the investigation. Therefore, an alternative technique is desirable.

According to the present invention, it is proposed that a means for generating a magnetic field is inserted into the splint such that it becomes located axially at a position corresponding to a feature of the splint, and a sensor is provided for detecting the magnetic field produced. Since any magnetic field is directional, it is then possible accurately to locate the position of the means for producing the field, and hence the location of the feature of the splint, such as the pre-drilled hole(s), corresponding to the location of the field-producing means.

Preferably, the means for producing a magnetic field comprises one or more solenoidal aerials to which alternating currents are applied so as to generate magnetic fields which may then be detected by one or more detection coils. Preferably, at least two detection coils are used, which are positioned on

opposite sides of the solenoidal aerial, so that the direction between the detection coils, at maximum signal strength, defines a line passing through the aerial, and hence through the pre-drilled hole in the splint. This enables the drilling operation to be accurate. In order to achieve this, it is necessary that the solenoidal aerial, or other means for generating a magnetic field, is accurately positioned within the splint. However, a variety of mechanical arrangements may be used to achieve this, including shaping the guide for the solenoidal aerial which matches the internal shape of the splint, or by having a latching arrangement attached to the solenoidal aerial, which, when correctly positioned, engages the holes in the splint into which the pin is to be inserted.

Although the present invention, as discussed above, is primarily envisaged for use in the detection of the location of a feature such as pre-drilled holes in a splint within a human or animal bone, the present invention is also applicable to the detection and pinpointing of other features of a splint within a human or animal body.

An embodiment of the present invention will now be described in detail, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a general schematic view of an apparatus according to the present invention;

Fig.2 is a detail of the probe head of the apparatus of Fig. 1;

Fig. 3 is a sectional view along the line z-z in Fig. 2; and

Fig. 4 is a sensor for use with the apparatus of Fig. 1.

Referring first to Fig. 1, a rigid splint of e.g. metal 10 is insertable into a broken bone 1, such as a femur, by standard surgical techniques. As shown in Fig. 1, the splint 10 is hollow, and has two holes 11, 12 therein adjacent one end. The splint 10 is positioned in the bone 1 with the end of the splint 10 having the holes 11, 12 being inserted first, and it is then necessary to drill through the bone 1 in order to insert pins through the bone 1, and through holes 11, 12 to secure the end of the splint to the bone 1. The present embodiment is therefore concerned with the accurate detection of the position of the holes 11,12.

A probe 15 comprises a probe head 16 mounted on one end of an elongate shaft 17. The shaft 17 has a length such that, when the probe head 16 is inserted into the splint 10, as shown by arrow 18, the probe head 16 coincides with the location of the holes 11, 12. As shown in Fig. 2, the probe head 16 supports a pair of transmission coils 20,21 which form solenoidal aerials. The transmission coils 20, 21 are connected by wires 22 to a transmitter 23. When the transmitter 23 is activated, either of the coils 20, 21 generate

a magnetic field.

Fig. 3 also shows that, in this embodiment of the present invention, the probe head 16 has a non-uniform shape which shape may correspond to the internal profile of the splint 10, so that, when the probe 15 is inserted into the splint 10, not only will the probe head 16 be located in the position corresponding to holes 11,12, but the transmission coils 20,21 will have their axes aligned with the axes of the holes 11,12. Thus, the directions of the magnetic fields produced by the transmission coils 20,21 define the axes of the holes 11,12.

Of course, alternative arrangements are possible for ensuring alignment of the transmission coils 20,21 and holes 11,12. For example the probe head 16 may carry suitable latching means which engages the holes 11,12 when the probe head is suitable positioned, thereby to ensure a more firm fixing of the probe head 16 in the splint 10 during time when the transmission coils 20,21 generate a magnetic field.

The sensor for detecting the magnetic fields generated by one of the transmission coils 20,21 is shown in Fig. 4. The sensor has two detection coils 30,31 mounted on a support 32. As can be seen by Fig. 4, the support 32 is shaped so as to receive e.g. a limb of the human or animal body in which the splint 10 has been inserted, and has a bracket 33 on which the detection coils 30,31 are positioned so that they

are spaced apart, but aligned. The detection coils 30,31 are connected to a suitable detector 34.

With the generator 23 activated, so that the transmission coils 20,21 are generating a magnetic field, the sensor is positioned so that the detection coils 30,31 are positioned on either side of the splint 10, and then the position of the bracket 33 is changed both linearly and rotationally, until the maximum signal strength is detected by the detector 34. At this position, the detection coils 30,31 are aligned with one of the transmission coils 20,21, so the line joining the detection coils 30,31 corresponds to the axis of the appropriate hole, 11,12. It is then possible to drill along the line between the detection coils 30,31, with confidence that the hole thus drilled through the bone will meet the appropriate hole 11,12 in the splint 10. This process can then be repeated for the other hole 11,12, detecting the magnetic field from the other of the transmission coils 20,21. Indeed, it is possible for drilling ducts to be formed within the detection coils 30,31 and the drilling operation to occur with the support 32 in place, thereby to ensure more accurate drilling.

As described above, the signal generated by the generator 23 will be an alternating signal of e.g. 76kHz. However, the present invention is not limited to the use of alternating signals, although these are

preferred. In a similar way, the present invention is not limited to the use of two detection coils, 30,31. In theory, one detection coil is sufficient but the use of at least two provides more accurate alignment. Indeed, it is possible to use additional detection coils for more accurate positioning. For example, if each of the detection coils 30,31 is replaced by an array of 4 coils, then a more accurate measurement of the maximum field position is possible.

Some splints 10 have a profile such as that shown in Fig. 5, in which there is an opening 40 to the interior of the splint 10 running along the length of the splint 10, and there is a projecting part 41 extending along the splint 10 on the opposite side from the opening 40. With such a splint 10, the probe head 16 may be shaped to have first and second projections 42,43 which are received in the opening 40 and projection 41 respectively, thereby ensuring that the probe head 16 has a defined orientation relative the splint 10. In this way, the transmission coil 21 (or the transmission coil 20) has its orientation defined accurately relative to the splint 10. Furthermore, as shown in Fig. 1, a stop 50 may be provided on the elongate shaft 17 of the probe 50. That stop 50 then limits the depth to which the probe head 16 can be inserted into the splint 10. The location of the stop 50 on the elongate shaft 17 may be made adjustable to adapt the apparatus to different

splints.

Although the above description refers to the use of a pair of transmission coils 20,21, it is possible to use one coil, or even use more than two coils. Indeed, due to the simplicity of construction, the use of one coil is currently preferred.

CLAIMS

1. A detection apparatus, comprising:

an object (10) positionable within a part of a human or animal body;

means (20,21) located within said object (10) for generating a magnetic field; and

a sensor (30,31,34) for detecting the orientation of said magnetic field relative to the part (1) of the body, thereby to determine the position of said object within the part (1) of the body;

characterised in that:

the object (10) is a splint having at least one fixed feature (11,12) therein, and the means for generating a magnetic field is aligned with said at least one feature (11,12) in the splint.

2. An apparatus according to claim 1, wherein the means (20,21) for generating a magnetic field is a solenoidal aerial, and the apparatus has means (23) connected to the solenoidal aerial for generating a signal in the solenoidal aerial (20,21), thereby to generate the magnetic field.

3. An apparatus according to claim 1 or claim 2, wherein the sensor (30,31,34) comprises at least two spaced apart detection coils (30,31) locatable on opposite sides of the means (20,21) for generating a magnetic field, the detection coils (30,31) being movable to permit the detection coils (30,31) to be aligned with the field generated by the means (20,21)

for generating a magnetic field.

4. An apparatus according to claim 1, wherein the at least one feature (11,12) is a hole.

5. A method of detecting an object (10) within a part (1) of a human or animal body, comprising:

inserting means (20,21) for generating a magnetic field into said object (10) to a predetermined position;

generating that magnetic field; and

detecting the orientation of that magnetic field by using a sensor (30,31,34) located outside the body;

characterised in that:

the object (10) is a splint having at least one fixed feature (11,12) therein;

the method further includes aligning the means for generating aligning the means for generating a magnetic field with said at least one feature (11,12) in the splint (10).

6. A detection assembly, comprising:

means (20,21) insertable into said object (10) positionable within a part (1) of a human or animal body for generating a magnetic field; and

a sensor (30,31,34) for detecting the orientation of said magnetic field relative to the part (1) of the body, thereby to determine the position of said object (10) within the body;

characterised in that:

the object (10) is a splint having at least one

fixed feature (11,12) therein, and the means (20,21) for generating a magnetic field is arranged to be alignable with said at least one feature (11,12) in the splint.

Fig. 1

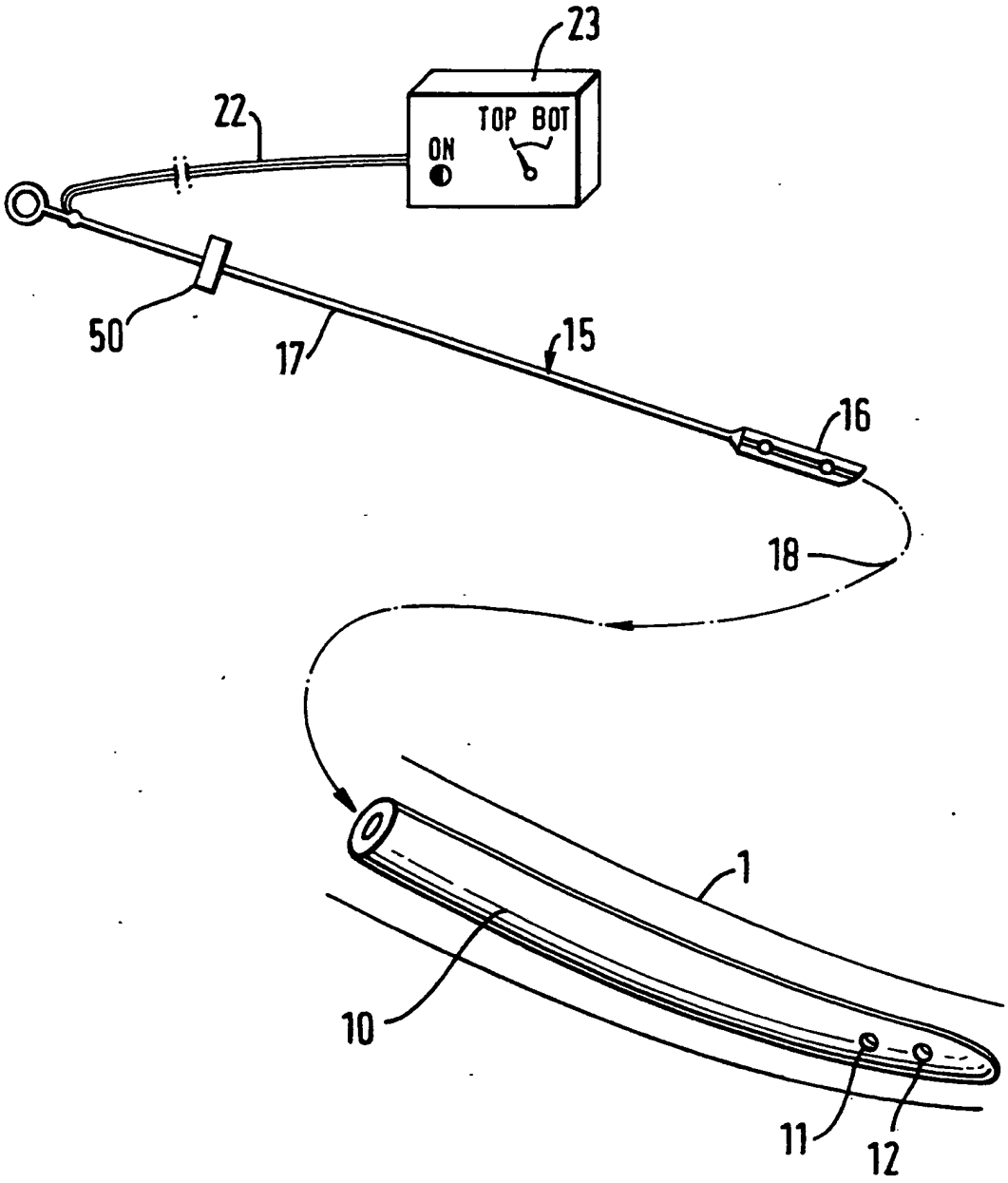


Fig. 2

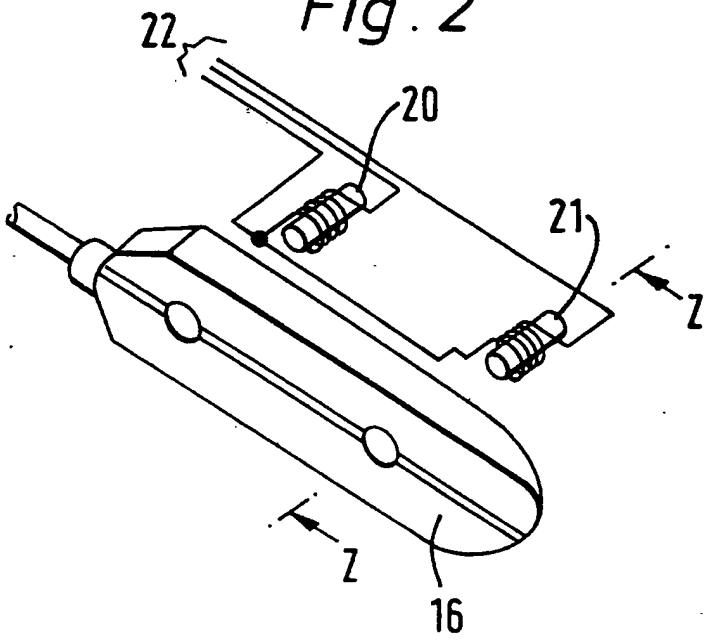


Fig. 3

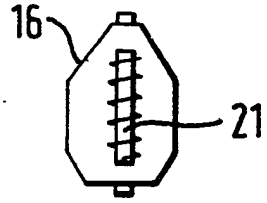
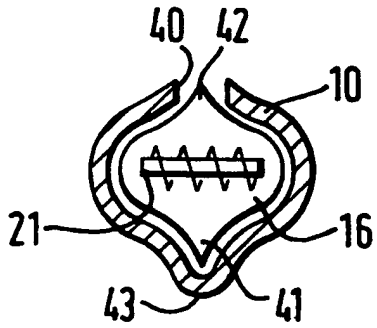


Fig. 5



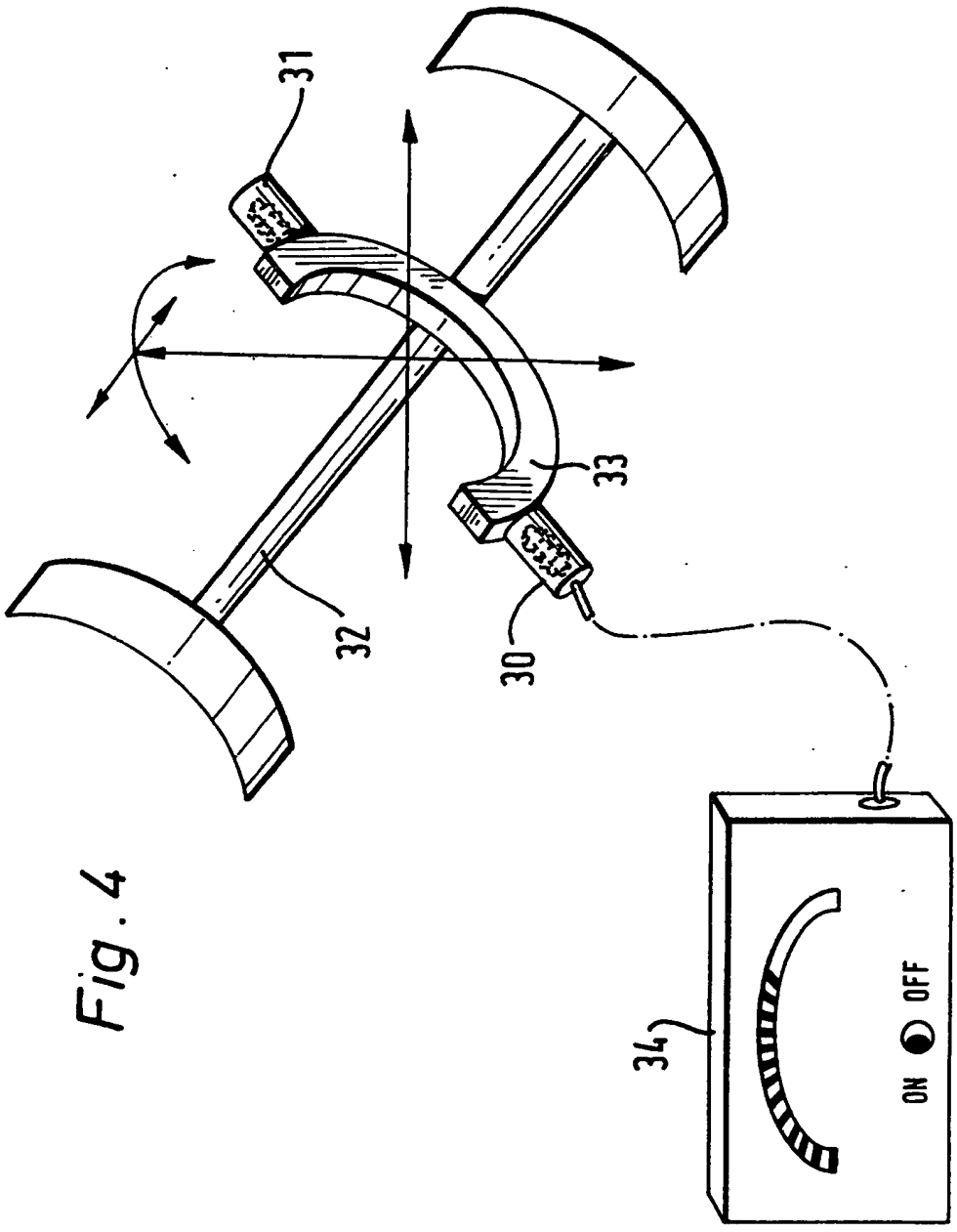


Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 92/01454

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 A61B17/16

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	A61B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[o]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	EP,A,0 135 804 (ORTOPEDIA GMBH) 3 April 1985 see page 9, line 9 - page 14, line 14 see figures	1,5,6
A	---	4
A	EP,A,0 097 401 (CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE) 4 January 1984 see page 5, line 11 - page 9, line 28 see figures	1-6

A	US,A,4 173 228 (VAN STEENWIJK ET AL.) 6 November 1979 see column 2, line 62 - column 3, line 59 see column 5, line 14 - column 6, line 55 see figures 1-3	1,2,5,6

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[o] Special categories of cited documents :[10]

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IV. CERTIFICATION

2

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26 OCTOBER 1992	03. 11. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	CHEN A.H. A. Chen.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
P,X	US,A,5 127 913 (THOMAS, JR.) 7 July 1992 see column 3, line 56 - column 5, line 14 see figures	1,5,6
P,A	-----	4

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9201454 SA 63140

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 26/10/92
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		JP-A- 60156443	16-08-85
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EP-A-0097401	04-01-84	LU-A- 84209	07-03-84
		US-A- 4552134	12-11-85
US-A-4173228	06-11-79	None	
US-A-5127913	07-07-92	None	